

**DRAFT**  
**Monitoring and Adaptive Management Sections**  
**for Selected Water Operations Conservation Measures**

**WOCM2a: Modify the Fremont Weir and the Yolo Bypass to provide for a higher frequency and duration of inundation.**

**Performance Monitoring Metric #1: Flow rate passing Fremont Weir (cfs) and duration (days)**

**Justification:** Flow rate and duration of flow over the Fremont Weir is the conservation measure action that creates inundated floodplain habitat within the Yolo Bypass.

**Target:** Mean flow over Fremont Weir of at least █ cfs for █ days over a 30-45 day period with no more than █ days without flows passing Fremont Weir.

**Monitoring approach:** A rating curve for water surface elevation and flow rates over the Fremont Weir would be developed and a remote sensor would be installed at the Fremont Weir that would continuously (e.g., hourly) monitor water surface elevations. Data from gage stations in upstream locations in the Sacramento River and its tributaries would be monitored to forecast flows expected at the Fremont Weir over the periods the weir is operated. Monitoring would be conducted over the term of the BDCP.

**Adaptive management triggers and responses:** If, after Fremont Weir operations have commenced, forecasts of Sacramento River flow to the Fremont Weir indicate that sufficient flow is not available to sustain inundation for a period of at least 30 days:

1. Continue operation of the Fremont Weir if conditions are such that benefits for splittail production and juvenile salmonid passage and growth exceed potential adverse effects on splittail and juvenile salmonids of reduced or discontinued flow into the bypass. Considerations for continuing Fremont Weir operations include contributions or forecasts of contributions of flow into the Yolo Bypass from the Westside tributaries.
2. Discontinue operation of the Fremont Weir if conditions are such that adverse effects on splittail and juvenile salmonids would likely exceed benefits of continuing to operate the Fremont Weir. Fremont Weir operations would be conducted to ramp down flows into the bypass such that the probability for fish stranding is minimized.

**Performance Monitoring Metric #2: Inundation duration (days) and extent (acres)**

## HANDOUT #2

**Justification:** The duration and extent of floodplain inundation are primary factors determining the success of splittail spawning, the extent of splittail spawning habitat, the extent of juvenile salmonid and splittail rearing habitat, and the extent food production and support to aquatic food web process (production and export of organic carbon, phytoplankton, zooplankton, and macroinvertebrates) (Sommer et al. 2001a,b, Harrell and Sommer 2003, Feyrer et al. 2006).

**Target:** Provide at least [ ] to [ ] acres of floodplain inundation for a period of at least 45 days.

**Monitoring approach:** A rating curve for determining the extent and duration of floodplain inundation based solely on flows entering the Yolo Bypass from the Sacramento River would be developed based flow rates and durations passing over the Fremont Weir and estimates of hydraulic residence time within the bypass.

**Adaptive management trigger and response:** Triggers and responses for this monitoring metric are the same as described for Performance Monitoring Metric #1.

### **Performance Monitoring Metric #3: Inundation frequency (years in which the Fremont Weir is operated)**

**Justification:** The duration and extent of floodplain inundation are primary factors determining the success of splittail spawning, the extent of splittail spawning habitat, the extent of juvenile salmonid and splittail rearing habitat, and the extent food production and support to aquatic food web process (production and export of organic carbon, phytoplankton, zooplankton, and macroinvertebrates) (Sommer et al. 2001a,b, Harrell and Sommer 2003, Feyrer et al. 2006).

**Target:** The Yolo Bypass is inundated with flows passing over the Fremont Weir for a period of at least 45 days at least [ ] out of every [ ] years.

**Monitoring approach:** Assessment based on recorded frequency and duration of bypass inundation events.

**Adaptive management trigger and response:** The inability to achieve the target would constitute a changed circumstance and would be addressed as described in Section 3.6, *Adaptive Management*.

### **Performance Monitoring Metric #4: Residence of adult covered fish species within [ ] mile of the Fremont Weir of greater than [ ] hours**

## HANDOUT #2

**Justification:** The number of adult covered fish species are present in the vicinity of the Fremont Weir and their duration are hypothesized to be indicators of the relative ability of adult fish to successfully pass the Fremont Weir into the Sacramento River with minimum of exposure to stranding and harvest risk.

**Target:** Residence of fewer adult covered fish species within [ ] mile of the Fremont Weir for greater than [ ] hours than observed from [year] to [year].

**Monitoring approach:** Initially, annual visual and/or remote surveys (e.g., hydroacoustics) would be conducted during periods the Fremont Weir is in operation to determine the numbers of adult covered fish species within the reach of the bypass extending ¼ mile downstream of the weir. This information would be evaluated to determine if adult fish are successfully able to pass the Fremont Weir without delays that could increase stranding and harvest risk. If survey data is not sufficient to evaluate the efficacy of fish passage, adult fish may be tagged (e.g., acoustic tag, radio tag, PIT tag, etc.) and monitored within the bypass to monitor the rate and success of upstream migration. Once the ability of adult fish to successfully pass the Fremont Weir is established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to confirm that passage success is being maintained.

**Adaptive management triggers and responses:** If passage of adult fish is impaired, the Implementing Entity would implement studies to identify the cause. If the cause is related to bathymetry/bypass topography, operation of the Fremont Weir, or design/operation of the new fish passage facility, the Implementing Entity would undertake appropriate actions to modify these factors to improve passage.

### Performance Monitoring Metric #5: Incidences of covered fish species stranding

**Justification:** Incidences of fish stranding is an indicator of the likely extent of covered fish species mortality from desiccation, predation, and harvest.

**Target:** Fewer incidences of fish stranding than the mean number of incidences reported from [year] to [year].

**Monitoring approach:** Initially, annual visual and other surveys (e.g., beach seining) would be conducted immediately following periods the Fremont Weir is in operation and flows are receding from the bypass floodplain to document stranding locations and magnitude. Once documented, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in stranding

location and magnitude that may result for changes in floodplain topography (e.g., formation of scour holes or sedimentation that create isolated pools).

**Adaptive management triggers and responses:** If the incidence of fish stranding exceeds the target, the Implementing Entity will undertake actions as appropriate to address site-specific causes of stranding at locations with the potential to strand the greatest numbers of fish. Likely anticipated actions could include altering floodplain topography to improve drainage or adjusting Fremont Weir operations to improve ramping flows.

### **Effectiveness Monitoring Metrics #1-3: Total organic carbon (mg/L), phytoplankton (mg/L chlorophyll a), and zooplankton (number/1,000 m<sup>3</sup>)**

**Justification:** Total organic carbon, phytoplankton, and invertebrate production within and export from the Yolo Bypass into Delta waterways are likely primary constituents of food production for covered fish species (Sommer et al 2001a, Schemel et al. 2004). Measurements of these constituents, therefore, are indicators of the contribution of this conservation measure towards improving food production potential within the Delta.

**Target:** Increase total organic carbon concentrations in Yolo Bypass outflows relative to concentrations in flows passing over the Fremont Weir by at least █ percent, chlorophyll a by at least █ percent, and invertebrate density by at least █ percent during periods the Fremont Weir is operated.

**Monitoring approach:** Take daily grab samples and measurements for total organic carbon, chlorophyll a, and zooplankton at the Fremont Weir during periods the weir is operated and at the outflow to Cache Slough over the term of bypass inundation. Assess measurements of total organic carbon, chlorophyll a, and zooplankton and performance monitoring results to establish relationships between season, extent, and duration of floodplain inundation and production and export of total organic carbon, chlorophyll a, and zooplankton. Once these relationships have been established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in production of these constituents over the term of the BDCP.

**Adaptive management triggers and responses:** If production and export of total organic carbon, chlorophyll a, and zooplankton do not achieve the targets, the Implementing Entity will undertake investigations to determine causes for insufficient production and export of these constituents or determine if the targets were established incorrectly given the uncertainties surrounding the internal and external factors that govern the capacity of the bypass to produce these constituents. Potential actions, if appropriate, that could be undertaken to improve production and export of these constituents could include modifying

Fremont Weir operations to increase hydraulic residence time within the bypass and operating the weir during warmer periods.

### **Effectiveness Monitoring Metric #4: Production of Sacramento splittail (number of larval and early juvenile splittail/10,000 m<sup>3</sup>)**

**Justification:** Measurements of Sacramento splittail production in the Yolo Bypass during periods the Fremont Weir is operated will provide the Implementing Entity with information necessary to determine the effectiveness of a range of weir operations in supporting splittail production.

**Target:** Increase the density of larval and early juvenile splittail densities in Yolo Bypass outflows relative to densities in inflows by at least  percent during periods the modified Fremont Weir is operated.

**Monitoring approach:** Take daily grab sample (500 um mesh net) measurements of fish eggs and larvae (ichthyoplankton) in the inflow to the weir and outflow to Cache Slough. Samples would be processed to identify and enumerate the density of each larval and juvenile Sacramento splittail and other fish species. Assess measurements of larval and juvenile splittail densities and results of performance monitoring to establish relationships between season, extent, and duration of floodplain inundation and splittail production. Once these relationships have been established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in production over the term of the BDCP.

**Adaptive management triggers and responses:** If the production of splittail does not achieve the target, the Implementing Entity will undertake investigations to determine causes for insufficient production or determine if the target was established incorrectly given the uncertainties surrounding the internal and external factors that govern the production of splittail. Potential actions, if appropriate, that could be undertaken to improve splittail production could include modifying Fremont Weir operations to improve conditions that support spawning and rearing habitat or improving other habitat elements such as vegetative structure.

### **Effectiveness Monitoring Metric #5: Percent survival of juvenile Chinook salmon and steelhead.**

**Justification:** Survival rates for juvenile Chinook salmon and steelhead using the Yolo Bypass during periods the Fremont Weir is operated will provide the Implementing Entity with information necessary to determine the relative effectiveness of a range of weir operations in increasing juvenile salmonid survival rates. It has previously been demonstrated that survival of juvenile

Chinook salmon was somewhat greater in the Yolo Bypass compared to the mainstem Sacramento River, although not statistically significant (Sommer et al. 2001b).

**Target:** Increase the survival of juvenile Chinook salmon and steelhead migrating through the Yolo Bypass by  percent relative to the survival of juvenile salmonids that migrate down mainstem of the Sacramento River between the Fremont Weir and Rio Vista.

**Monitoring approach:** Conduct comparative mark-recapture experiments under a range of Fremont Weir operations (e.g., using CWT, acoustic, radio, PIT tags) using juvenile Chinook salmon and steelhead released into the bypass and in the mainstem Sacramento River downstream of the weir. Monitoring the number of marked fish released from each of the upstream locations as they pass near Rio Vista will provide the data necessary to assess the difference in survival rates between the migration routes. Once a relationship between weir operations and juvenile salmonid survival rates have been established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in survival over the term of the BDCP.

**Adaptive management triggers and responses:** If the survival of Chinook salmon and steelhead passing through the Yolo Bypass does not achieve the target, the Implementing Entity will undertake investigations to determine causes for insufficient survival rates or determine if the target was established incorrectly given the uncertainties surrounding the internal and external factors that govern the survival of juvenile salmonids. Potential actions, if appropriate, that could be undertaken to improve juvenile salmonid survival could include modifying Fremont Weir operations to improve rearing habitat conditions or reduce occurrences of stranding.

### **Effectiveness Monitoring Metric #6: Growth of juvenile Chinook salmon and steelhead (mm/day).**

**Justification:** Determining growth rates of juvenile Chinook salmon and steelhead using the Yolo Bypass during periods the Fremont Weir is operated will provide the Implementing Entity with information necessary to determine the relative effectiveness of a range of weir operations for increasing juvenile salmonid growth rates. It has previously been demonstrated that growth of juvenile Chinook salmon was greater in the Yolo Bypass compared to the mainstem Sacramento River (Sommer et al. 2001b).

**Target:** Increase the growth rate of juvenile Chinook salmon and steelhead migrating through the Yolo Bypass by  percent relative to the growth rates of

juvenile salmonids that migrate down mainstem of the Sacramento River between the Fremont Weir and Rio Vista.

**Monitoring approach:** Conduct comparative mark-recapture experiments under a range of Fremont Weir operations (e.g., using CWT, acoustic, radio, PIT tags) using juvenile Chinook salmon and steelhead released into the bypass and in the mainstem Sacramento River downstream of the weir. Capturing and measuring the length of marked fish released from each of the upstream locations as they pass near Rio Vista will provide the data necessary to assess the difference in growth rates between the migration routes. Once a relationship between weir operations and juvenile salmonid growth rates have been established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in growth rates over the term of the BDCP.

**Adaptive management triggers and responses:** If the growth of Chinook salmon and steelhead passing through the Yolo Bypass does not achieve the target, the Implementing Entity will undertake investigations to determine causes for insufficient growth rates or determine if the target was established incorrectly given the uncertainties surrounding the internal and external factors that govern the growth of juvenile salmonids. Potential actions, if appropriate, that could be undertaken to improve juvenile salmonid growth rates could include modifying Fremont Weir operations to increase the time that juvenile salmonids remain in the bypass.